River Bank Rehabilitation in Sand-Bed Channels: A Case Study of the Pine River

Ahmed Siddiqui\textsuperscript{1}, Paul Villard\textsuperscript{1}, Fred Dobbs\textsuperscript{2}

\textsuperscript{1}GEO Morphix Ltd., Milton, Canada
\textsuperscript{2}Nottawasaga Valley Conservation Authority, Utopia, Canada

5\textsuperscript{th} International Conference on Natural Channel Systems
September 26-27, 2016, Niagara Falls, Ontario
Outline:

• Unique characteristics of sand-bed rivers
• Issues with working in sand
• Use of alternative bioengineering methods
• Assessing stability
• Case Study: Pine River
Sand-Bed Channels:

Characteristics:
- Mobile bed load
- Highly erodible substrate
- Naturally adjusting planform

Issues with typical rehabilitation:
- Outflanking
- Undermining
- Shifting and sinking

Factors influencing stability:
- Riparian vegetation
- Presence of woody material
Sand-Bed Channels

Legend
Channel banks in:
- 1971
- 1978
- 1983
- 2006
- 2012
- 2022

Meander position in:
- 1971
- 1978
- 1983
- 2006
- 2012
- 2022

Meander A
PROPOSED OUTFALL

Meander B
PROPOSED OUTFALL

Meander C
PROPOSED OUTFALL

Predicted Meander Positions

Typical Rehabilitation
Alternative Bioengineering Methods

Large woody debris
  • Examples: root wads, conifer bank treatment

Advantages:
  • Increased roughness at bank
  • Reduce velocity and shear stresses
  • Deformable
  • Easy to install
  • Traps sediment
  • Floats
Determining Restoration Methods

Key Factors to Consider:

- Planform evolution and systematic adjustments
- Channel morphology
- Extent of erosion
- Resident aquatic species
- Type of woody material
- Configuration of treatment
- Potential success of supplemental planting
Determining Restoration Methods

Morphological and Hydrological Investigation

• Background review: historical assessments; hydraulics and hydrology
• Field investigation: geomorphological assessments and topographic surveys

Technical Analyses:

• Migration rates
• Erosion threshold calculation
• Force balance analysis
• Depth of scour analyses
Case study: Pine River
Existing Conditions
Proposed Restoration Method
Force Balance Analysis

1) Factor of safety with respect to Buoyancy

\[ FS_B = \frac{W_{BL}}{F_B} \]

Stable when \( FS_B > 1 \)

*Here: \( FS_B = 40 \)*

2) Factor of safety with respect to Sliding:

\[ FS_S = \frac{F_{FS}}{F_D} \]

Stable when \( FS_S > 1 \)

*Here: \( FS_S = 4 \)*

* Anchoring treatment provides additional stability
Shear and Meander Migration

• Maximum shear at meander bend
  • Determine maximum boundary shear for the proposed cutoff channel

• Meander Migration
  • Calculate rates of meander migration for the proposed cutoff channel
Implementation and Construction

- Timing: window for in-stream work; window for breeding season for migratory birds
- Delineate construction limits protecting trees, sediment erosion control to protect water quality and aquatic habitat
- Isolate area to work in dry conditions; pump and filter water from creek over vegetated area
- Fish rescue in isolated work area
Post-Construction – Fall, 2015
Post-Construction – Summer, 2016
THANK YOU!